

EVACUATION OF AERIAL PASSENGER TRAMWAYS & SKI LIFTS

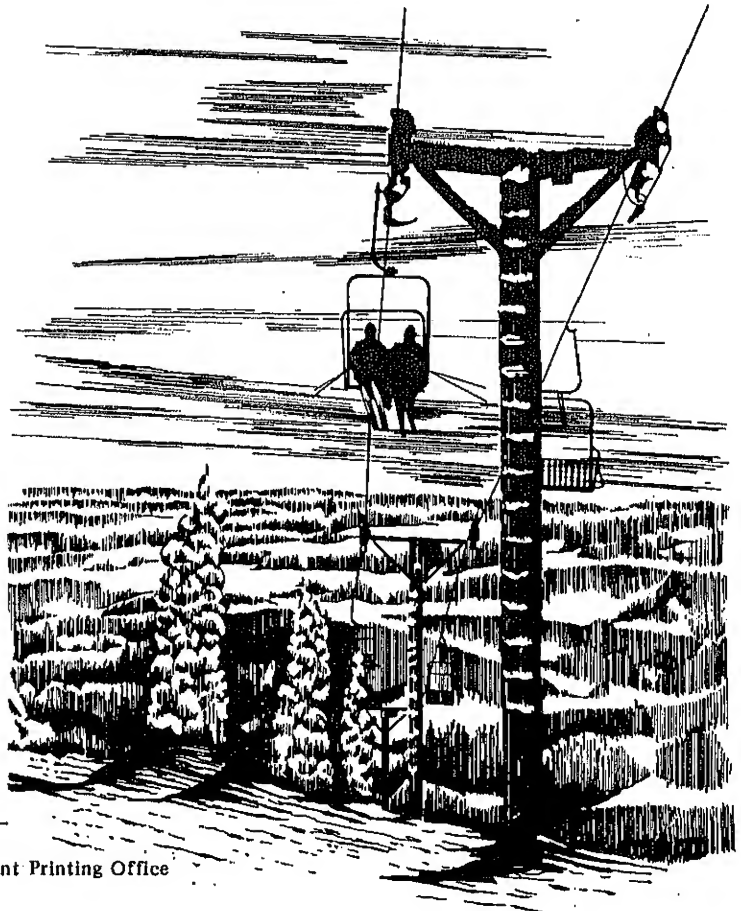
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INTRODUCTION

PURPOSE

This report provides general information on the evacuation of aerial passenger tramways and ski lifts. It is intended to familiarize the reader with basic characteristics, considerations, procedures, and equipment involved in the evacuation of aerial passenger tramway carriers. It will assist the owner and manager of aerial tramway facilities in recognizing the need to provide for evacuation and his responsibility for both the planning and implementing of evacuation procedures. It will suggest evacuation methods, procedures, and equipment for the personnel actually performing carrier evacuations. It cites the responsibilities the Forest Service bears as an authority having jurisdiction over the installation and operation of aerial tramway facilities and the evacuation of these facilities.

This summary of information will serve as a basis for discussion, comparison, and the selection of evacuation methods and equipment. It is not intended to establish specific direction, restrictions, or requirements for any particular installation.

SCOPE

Aerial passenger tramway evacuation is an extremely broad and ever-changing subject. Variations arise with tramway design, location, and operating conditions. Carrier sizes range from a single chair to a 120-passenger cabin. Operating heights vary from a few feet to well over 1,000 feet above ground. Conditions vary from those of a subtropic paradise to those of a high mountain area exposed to extreme temperatures, wind, and weather. Locations vary from city parks to inaccessible mountain terrain.

No single evacuation procedure or piece of equipment is applicable to all tramway types and locations. Methods, equipment, and requirements for evacuations are constantly changing. Mandatory requirements that may be imposed upon the industry should not limit the introduction of new methods and equipment.

Evacuation is discussed with reference to three basic aerial passenger tramway lifts, the most frequently encountered type, which use chairs as carriers and is referred to as "chair lifts"; (2) small, enclosed systems. These types are defined under "Ter

It is not feasible to identify or list all the products used in the evacuation of aerial carriers; instead, representative manufacturer's trade name or other designation. All use of manufacturer or corporation names is for the information and does not constitute an official evaluation, recommendation, or approval of any product or service to the exclusion of others.

The appendices contain pertinent reference material which is reprinted with the permission of the originator and is for information only. No recommendations or requirements are necessarily applicable to any particular installation or operation.

This text contains terms commonly used in the aerial passenger tramway industry and presupposes a working knowledge of that industry by the reader.

For basic descriptions of aerial passenger tramway types and terminology the reader may refer to "Aerial Tramways, Ski Lifts, and Tows – Description and Terminology" (EM-7320-1), available from:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

TERMINOLOGY

AERIAL PASSENGER TRAMWAYS

The term "aerial passenger tramway" designates a conveyance which transports passengers in carriers suspended from wire rope or other elevated support structures. More specifically, aerial tramways are designated as:

- *Reversible Aerial Tramways.* The carrier (or carriers) reciprocate between terminals. Capacities range from 12 to 120 passengers. There is a cabin attendant or conductor in each carrier. Evacuation equipment is carried in the cabin.

- *Gondola Lifts.* The carriers circulate either continuously or intermittently around a closed system. They make U-turns in the terminals and circulate on generally parallel and opposing paths. Generally, cabins are enclosed and accommodate six passengers or less. There is no attendant. Each carrier may contain rescue cord, instructions, and other evacuation gear.

- *Chair Lifts.* Passengers are transported in chairs on a continuously circulating or intermittently circulating system. Carrier capacities range from one to four persons; they may be open or partially enclosed; and they may have a restraining bar ("safety bar") or strap and a combined arm and foot rest.

- *Special Tramway Types.* The combination and variations of the basic types of aerial passenger tramways are not relevant to the subject of passenger evacuation and will not be treated in this text.

EVACUATION OF AERIAL PASSENGER TRAMWAYS

Evacuation of an aerial passenger tramway involves the removal of occupants from a stranded chair, gondola, cabin, or other aerial carrier, and the lowering of the passengers to the ground, snow surface, or other safe place.

Evacuation should not be confused with methods used initially in the event of power failure or other interruption of normal operation. Most aerial tramway and ski lift installations have auxiliary power units with an independent secondary power source to move the carriers and passengers along the line in the event of primary power failure. Reversible aerial tramways may have an entire rescue system to move passengers from a stranded carrier to a terminal area. The use of auxiliary power or a rescue system does not constitute carrier evacuation in the sense of this title.

Evacuation Classification

Evacuation of passengers from the stranded carriers of an aerial passenger tramway system is classified as either individual or general:

- **Individual evacuation** involves the removal of an occupant (or occupants) of one carrier; usually this occurs adjacent to a loading or unloading area. Passengers in remaining carriers are not in jeopardy or otherwise involved.
- **General evacuation** involves the removal of occupants from all carriers when it is impossible or inadvisable to move the loaded carriers or to use the rescue system.

Evacuation Methods

Current practices are described below; one or more evacuation methods may be required at a particular site.

- ***Mechanical Equipment Evacuation.*** Evacuation by this method involves removal of passengers from a stranded carrier by use of mechanical equipment such as portable slides, cranes, cherrypickers, helicopters, and other aerial rescue devices.
- ***Ladder Evacuation.*** Passengers are frequently removed from a carrier by use of a ladder that may be hand-carried and placed by a rescue team, or mounted on mobile mechanical equipment and placed either by hand, hydraulically, or mechanically.
- ***Rope Evacuation.*** The most common method of evacuating passengers from a carrier is the use of a synthetic fiber or wire rope, that may pass over or through a ring, wheel, wire rope, or other support. Rate of passenger descent may be regulated by hand (see Belay, page 5) or by a mechanical descent control device.
- ***Self-Evacuation.*** The evacuee is required to perform duties other than merely securing himself to a device or climbing down a ladder. Self-evacuation is limited to trained personnel authorized under specific conditions set forth by management.

Rescue Devices for Evacuation of Carrier

The unit used to support or contain a person or persons being evacuated from an aerial passenger tramway carrier is referred to as a rescue device. These devices are classed as follows:

<i>Stand-up Type</i>	An elongated, T-shaped device which supports the evacuee in a standing position. Removal of skis is not required.
<i>Seat Type</i>	A rigid, T-shaped carrier which supports the evacuee in a seated position. Removal of skis is not required.
<i>Sling Type</i>	A flexible strap or belt which is attached to the evacuee. Removal of skis is not required.

Container Type A canvas bag, basket, or other container used to hold an evacuee. Skis must be removed.

Security Tie A strap, belt, or chain used to secure the occupant to an evacuation device. This tie may be placed and adjusted by an attendant or by the occupant under direction of the evacuation team. It must be simple to place and adequate to secure an unconscious evacuee to the rescue device.

Evacuation Plan

A written evacuation plan with procedures for an aerial carrier evacuation is required. The management of a transport facility or recreation area is responsible for its initiation and implementation. Frequently, an authority having jurisdiction must concur and approve the plan. The plan also should meet area requirements for insurance companies and other interests.

Authority having jurisdiction is a public or private body empowered by law or common agreement to enforce rules and regulations controlling the operation of aerial passenger tramway equipment. In the event that an operation is subject to the jurisdiction of two or more authorities, the more restrictive requirements of the two are applicable.

Evacuation Terminology

The words listed have the following meanings in evacuation terminology:

Sweep A visual check of a designated length of the aerial tramway line to determine the status of passengers, carriers, and evacuation gear.

Rescue Rope A fiber or wire rope used to lower a passenger from a stranded carrier during an evacuation.

Cord A light-weight line used to raise, lower, or position a rescue rope and gear for a carrier evacuation. It may be located in the carrier and accessible to passengers or may be dispatched by the evacuation crew during the evacuation.

Rescue Cache A storage area used to contain and protect rescue rope and gear.

Belay A technique or procedure used to regulate or control the descent rate of a weight (acting under the influence of gravity) suspended from a rope. This may be accomplished with or without the use of mechanical equipment or an anchorage.

Carabiner A metal ring used in the rigging of rope systems.

Rescue Eye

A ring or other appurtenance attached to a carrier and intended for the support and carriage of a rescue rope.

Ascent Device

A mechanical device used to assist an evacuation crew member to gain access to a stranded carrier. It may be used in vertical ascent or for access along a track or haul cable.

EVACUATION PLANS

RESPONSIBILITY FOR EVACUATION PLANS

Conditions sometimes interrupt normal operation of aerial passenger tramways and preclude the use of auxiliary measures to bring carriers and passengers to terminal areas. An emergency situation then exists, and carriers must be evacuated. Successful evacuation can only be accomplished by means of procedures which have been planned in advance.

Area management is responsible for developing an evacuation plan, as well as being able to implement it fully under any conditions of public operation. The plan is often prepared jointly with the director of ski patrol activities or others who will perform the evacuations. Nevertheless, the responsibility for the entire procedure must remain with the area management.

Frequently, the evacuation plan is prepared jointly with, or under the direction of, the authority having jurisdiction over aerial passenger tramway operations in the area. This authority must ensure that the plan contains the minimum information necessary for full implementation, covers all aerial facilities, and is adequate for all operating conditions. A detailed account of Forest Service responsibilities (as an example of the responsibilities of an authority having jurisdiction) is contained in Appendix C.

ESSENTIALS OF AN EVACUATION PLAN

An evacuation plan must be prepared for each aerial passenger tramway facility to transport the public or area personnel. When a number of similar facilities are in operation, the plan may include general provisions applicable to all and specific instructions, as required, for each installation. It must be detailed and specific on all aspects of the evacuation procedure. At the same time, in those instances when the evacuation plan becomes a part of a Winter Sports Site Safety Plan or other contractual agreement, it should not be prepared in a manner which places the facility in an untenable legal position during either normal operations or emergency conditions.

The essential stages of the plan are:

- Preparation for evacuation.
- Performing an evacuation.
- Activities following an evacuation.

On the following pages, the procedures in each stage are described as they apply to the evacuation of a chair lift, since that is the most common type of aerial passenger tramway. There would be minor variations for tramways with gondola carriers and considerable differences for the reversible tramways.

Preparation for Evacuation

Steps in preparation for an evacuation are:

- Designate the person (or staff position) and alternate persons (or positions) who will make the decision for a general evacuation.
- Set up procedures for notifying all personnel involved that a lift evacuation alert exists and for making preliminary preparations.
- Designate a single individual with complete authority and responsibility for the evacuation and for restarting the aerial tramway following the decision to evacuate.
- Identify the communication procedure to be used and the stations that will remain manned during the entire evacuation process. Contact must be maintained between evacuation teams, lift terminals, and management personnel.
- Notify passengers of the evacuation; reassure them, inform them of safety measures, and determine problem areas, if any.
- Specify the evacuation methods to be used along the entire tramway. Designate locations and contents of each of the rescue caches. Provide for storage and limitations on use of evacuation gear during non-operating periods.
- Inspect each rescue cache to determine the presence and proper condition of evacuation gear.
- Stipulate the requirements for trained evacuation personnel during public operation. Designate training requirements to maintain qualified personnel.
- Determine the number of persons needed on an evacuation team and the number of teams required to accomplish the evacuation within the time limit set by management and the authority having jurisdiction.
- Establish first aid facilities. Provide for the comfort and safety of evacuees and passengers awaiting evacuation.
- Determine transportation requirements to a lower terminal or other points of comfort and safety for evacuees. Include provisions for the return or safekeeping of evacuees' skis and other personal effects.

ne that all passengers have been evacuated and all e, to ascertain that all ropes and other evacuation he line, and to report to management that the nd the lift readied for restart or repair.

Performing an Evacuation

The plan may not set forth a step-by-step procedure for the actual evacuation, but it should contain specific directions that are pertinent to the particular installation. Details might include these steps:

- Designate the portions of the lift to be served by each evacuation method.
- Stipulate the methods to be used for moving evacuation gear into position and for placing light lines or cords under all operating conditions.
- Determine the methods and procedures necessary for reaching stranded carriers (particularly gondolas, and occasionally chairs and large cabin carriers).
- Specify instructions for placing, using, inspecting, and caring for evacuation rope, carriers, access devices, mechanical equipment, and other evacuation service units.
- Determine evacuation crew size, number of crews, and procedures.
- Provide for (or limit) self-evacuation of area maintenance, operating, and evacuation personnel.
- Designate a person to be responsible for administering first aid to evacuees and passengers awaiting evacuation. Set up the reporting procedure for accident victims and others receiving first aid or other medical assistance.
- Provide for transporting or accompanying evacuees to a shelter or other comfortable and safe place.

Activities Following an Evacuation

The plan should prescribe the activities which follow an evacuation.

- Collect, inspect, repack, and return all evacuation equipment to its proper storage area or cache.
- Provide for a meeting of key evacuation personnel and management to evaluate the evacuation and prepare all reports.
- Determine the requirements for reporting the details of the evacuation to authorities having jurisdiction, and file required reports to State or Federal agencies. Report all deaths or injuries and file insurance reports. Provide for the release of information concerning the evacuation to the news media.
- Establish policies at management's discretion regarding courtesies to be extended to evacuees to maintain good will and to minimize potential claims for damages.

EVACUATION PROCEDURES, REQUIREMENTS, AND EQUIPMENT

This chapter presents a discussion of various procedures, requirements, and equipment available for aerial passenger tramway evacuations. It is intended to assist in the selection of methods and equipment for a particular installation, application, or location. Requirements, limitations, and specific recommendations are presented as a basis for discussion and to indicate that such criteria need to be established by owners and authorities having jurisdiction.

PROCEDURES FOR THE GENERAL EVACUATION OF CHAIR LIFTS

The chair lift is the most prevalent type of aerial passenger tramway and the one most frequently involved in evacuations. Since many procedures and much of the equipment used for chair lift evacuations are equally applicable to other types of tramways, chair lifts will be covered in detail and used as points of reference in later discussions.

Rope Evacuation

Rope evacuation is the most universally applicable and widely used chair lift evacuation method. It can be used regardless of the chair's height, capacity, enclosure, foot rest or safety bar, access under the lift, or climatic and operating conditions. Evacuation personnel require a minimum of instruction and practice to maintain proficiency in using the method and equipment involved. Evacuees readily understand and accept the procedure. With proper use of equipment, this method offers safety to both the evacuee and evacuation personnel. When correctly executed, it is fast and flexible: any number of units or teams may be used to meet evacuation time requirements for prevailing operating conditions. Equipment is inexpensive, reusable, easily stored, independent of mechanical malfunction, and readily checked for proper operating condition. During an evacuation, passengers are required to follow simple instructions for placing and adjusting a security tie.

Selection, use, and care of the rescue ropes are critical to this method's success. The industry has simplified selection by stipulating that the rescue rope must be nylon or polyester (Dacron) with a minimum diameter of 7/16 inch. Rope life is dependent upon care and use. For example, when nylon or polyester rope passes over a wire rope, its life is dependent upon the surface condition of the wire rope. Since fraying of outer fibers on the rescue rope indicates loss of strength, it must be inspected frequently for this early sign of deterioration.

Procedures and equipment for rope evacuation are discussed below.

- *Placing the Rescue Rope.* Methods of placing the rescue rope in position for evacuation depend upon chair height and operating conditions. For an extremely low profile, it may be thrown directly over the wire rope support cable. When this is not possible, a cord or light line may be attached to a weight (e.g., a baseball imbedded with a screw-eye) and thrown across the cable. Under conditions of greater line height, such mechanical devices as a crossbow and arrow or a cartridge-fired line heaver may be used to

position the light line. Rescue rope can also be placed from a tower and walked into position at succeeding chairs by ground crews.

Generally, the rescue rope is placed across the single cable supporting the chair. An alternate arrangement of crossing both the upgoing and return support cables should be considered when the interior of the chair lift is free of control and communication lines. This method offers the advantage of a 90° bend at each cable support point as opposed to the 180° bend when using a single support cable.

- **Supporting the Rescue Rope.** Usually, the lift cable is used to support the rescue rope. If the cable surface is free of sharp barbs or nicked wire, it does little damage. Friction develops when the rope is bent across the cable and aids in controlling the rate of descent of the evacuee. Provision should be made for protecting the rescue rope from rough wire surfaces and preventing entanglement with chair grips. Devices intended for this purpose, such as the *Line Saver*¹ are excellent.

The rescue rope may be supported on the chair hanger by an *eye* or other specially prepared support. Use of this device means that the passenger must thread the rope through the eye. The safety of the evacuee depends upon the structural capability of the support and the small-diameter steel rod frequently used for this purpose may damage the rescue rope. Hence, when this device is furnished, it must be checked for adequacy during the chair lift load test period. Usually it is less satisfactory than using the cable to support the rescue rope.

- **Types of Lowering Devices.** Several types of lowering devices are in common use for rope evacuation of carriers.

Seat-type Stirrup or T. This is the most widely-used suspension or lowering device. It accommodates passengers of all sizes and weights and permits evacuation of passengers wearing skis. With a security tie around his chest, it is safe for an evacuee who loses consciousness. There is reasonable comfort and reassurance for the evacuee since, prior to leaving the chair, he is fully secured in the evacuation device.

The unit should be light-weight and easy to handle and store. Structurally, it must accommodate a passenger weight of 250 pounds with a safety factor of 5. The seat must be smooth on the underside to permit sliding across the chair. The security tie must fit all evacuees snugly. Placement and adjustment of the tie should be obvious to the evacuee and it should be possible to accomplish any adjustment without removing his gloves. A chain and snap link provides excellent adjustment. Automobile or airline seat belts are satisfactory when dispatched to the evacuee in the open position, requiring only the mating of a metal-to-metal contact and tightening by pulling a single strap.

Standup Device.² A frequently-used passenger suspension device, it is similar to the seat carrier except that the evacuee must stand on a support plate and secure himself to the center support stem. Its use does not require ski removal, but care must be taken to prevent the evacuee's feet from slipping from the support. Some evacuees feel insecure stepping

¹ *Distributor, Hall Ski-Lift Company, Incorporated, Watertown, N. Y.*

² *Manufacturer and distributor, Hall Ski-Lift Company, Incorporated, Watertown, N. Y.*

onto the suspended support before being fully secured. The standup device is somewhat less easily handled and stored than the seat carrier.

Harness Device. Occasionally, a harness-type suspension device is used which is a variation of the standard parachute harness. Color coding and other methods are used to make it easier for an inexperienced person sitting in a chair to position and adjust it, and to capitalize on the high degree of security and comfort afforded by such a device.

*Under-Arm Sling Device.*³ The under-arm sling device is a wide, padded-fabric sling which is positioned under the arms (fig. 1). Minimum adjustment of a security strap across the chest is all that is necessary. The sling accommodates all passenger sizes and weights and its use does not require removal of skis. Sliding from the seat presents no problem since body weight is taken by the rescue rope while the evacuee is seated.

Bags. Some chair lifts are still evacuated by use of a canvas or nylon bag into which the evacuee slides for lowering. The removal of skis is required. If deep enough to extend well above the tallest passenger's center of gravity, it is entirely safe. Although many evacuees are apprehensive about entering the bag from a chair, they feel secure once inside the bag. This method is used for evacuation of passengers from a gondola or a large cabin tramway but, for evacuation from chair lifts, it is less desirable than other types (fig. 2). Removed skis and other personal property can be lowered with the passenger when such action is expedient to the entire evacuation procedure.

• *Controlling the Descent of the Evacuee.* The majority of rope evacuations are accomplished by using a belay operated by an experienced person, with a backup for emergency conditions. Standing hip, arm wrap, seated hip, and other belay methods may be used by the belayer who should be positioned slightly downhill from the evacuee (fig. 3) and should wear gloves and use crampons on slippery surfaces. Brake belays and anchorage may be used under special conditions. The method selected should be practical and used only by those qualified to perform the task.

Only area evacuation personnel should employ a descent control device dependent on operation by the evacuee (fig. 4). A mechanical descent control device operated by experienced ground personnel may be used if it is not subject to overheating or mechanical failure and does not damage the rescue rope.

Ladder Evacuation

Ladders constitute the second most common method of chair lift evacuation. This method is fast and safe for line heights of 25 feet or less over accessible terrain. It is a simple procedure easily mastered by evacuation personnel and the evacuee. Skis must be removed

³*Manufacturers and Distributors: Mr. Thomas Hitesman, 108 College Street, Asheville, N.C. 28801; and Hall Ski-Lift Company, Incorporated, Watertown, N.Y.*



Figure 1. Rope evacuation using underarm sling device.

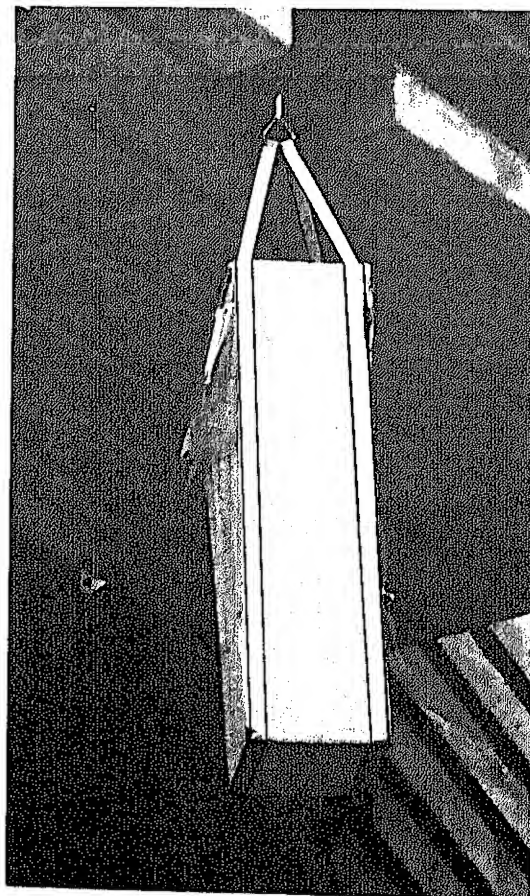


Figure 2. A deep canvas bag being used in a double reversible tramway cabin.

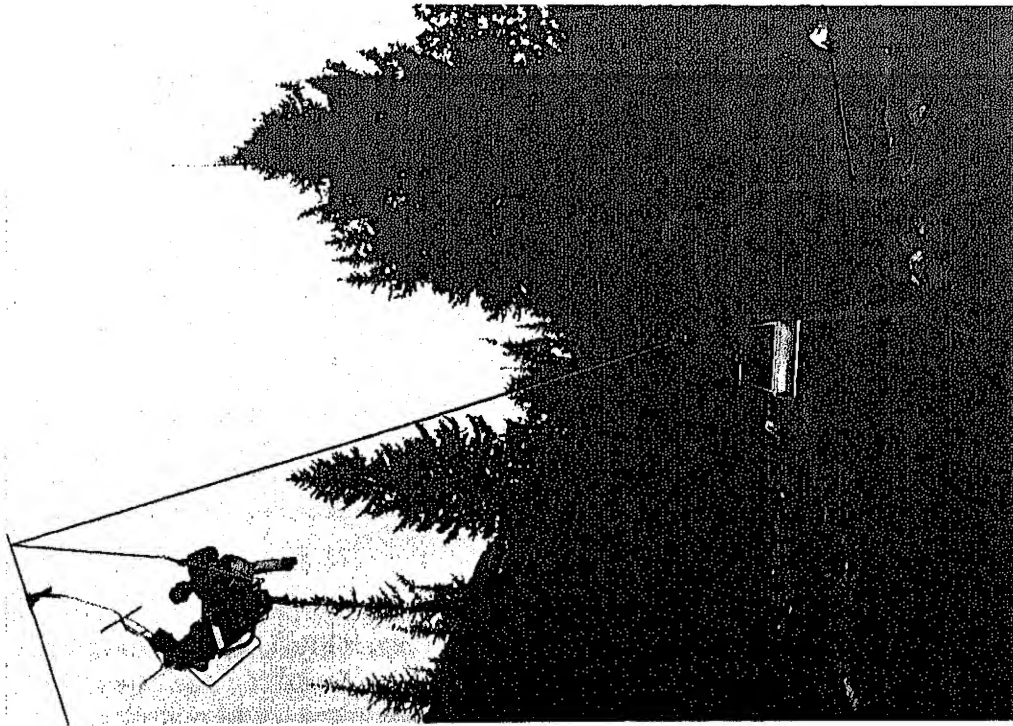


Figure 3. Rope evacuation of double chair lift using primary belay and backup belay.

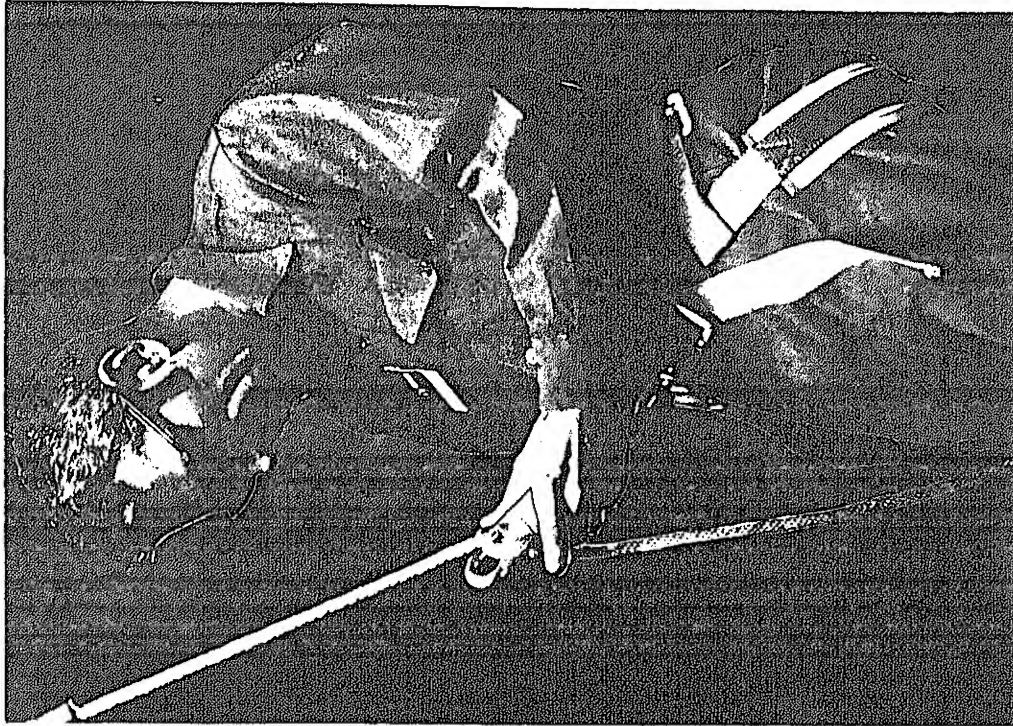


Figure 4. Self-evacuation using a descent control device.

from passengers by evacuation personnel and carried or lowered to the ground (fig. 5). Any number of ladders may be used to meet general evacuation time requirements. Equipment cost is reasonable and when ladders are reserved for evacuation use only, replacement is seldom required. Passengers are expected to have a reasonable degree of physical dexterity to execute this evacuation procedure.

Ladders should be of light metal or fiberglass and preferably of fixed length. The cable attachment is most important; since it must remain in place as cable or ladder move during loading, it must prevent rotation of the ladder, and it must slide freely along the cable for positioning and moving. A simple hook with a deep, narrow throat is the preferred attachment because it does not need to be latched or locked in position (fig. 6).

The ladder should be positioned at the chair by moving in from above and placing the ladder base downhill (fig. 7). This permits the passenger to place his feet on the rungs from a normal seated position. The ladder is usually handled by a crew of three. An attendant must climb the ladder to remove skis and assist passengers while two persons stabilize the base. There is no danger of losing ladder support with this method, and chair interference for the evacuee is minimal. Skis removed from passengers should be lowered or handed down, never thrown or dropped.

Ladders mounted to mechanical equipment are excellent for chair lift evacuations. The ladder must be positioned after the vehicle has moved into place to prevent injury to persons in an open chair. If possible, the position of the ladder relative to the chair should be the same as for those placed by hand.

Mechanical Equipment Evacuation

Evacuation by the use of mechanical equipment has received increasing consideration in recent years. Mechanical methods are particularly adaptable to chair lifts and to low lift lines over accessible terrain. Some suitable types of equipment are discussed below:

Rigid Slide. Mounted on a tracked over-the-snow vehicle, the rigid slide offers the ultimate in evacuation. The evacuee stands on the inclined ramp and slides or walks away from the chair. It is expensive and appropriate only for low lines over accessible terrain.

Portable, Nonrigid Slide. A portable slide similar to the emergency evacuation slide used on aircraft may be used for a chair lift. The method of raising the slide to position and attaching it to the chair is similar to that of placing the rescue rope. The procedure requires passengers to remove their skis, which renders it less desirable than more conventional methods.

Cherrypickers. This mechanism is used by firemen, powerline workmen, and tree trimmers; cherrypickers are suitable for the evacuation of chair lifts in amusement parks or other locations where the units are readily available.



Figure 5. Attendant removes skis prior to ladder evacuation of double chair lift.

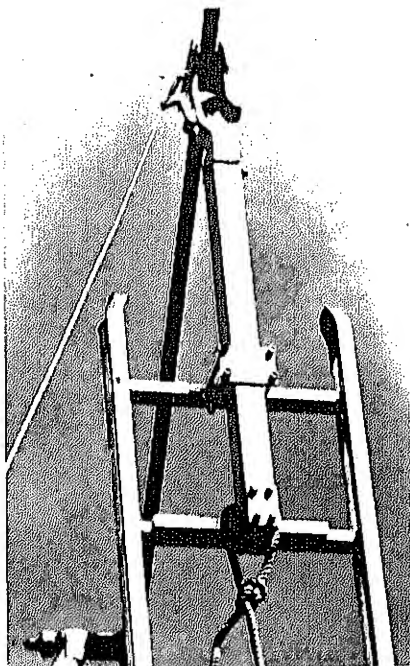


Figure 6. Experimental device for attaching ladder to cable. This unit uses "shepherd's crook" principle with a safety latch.

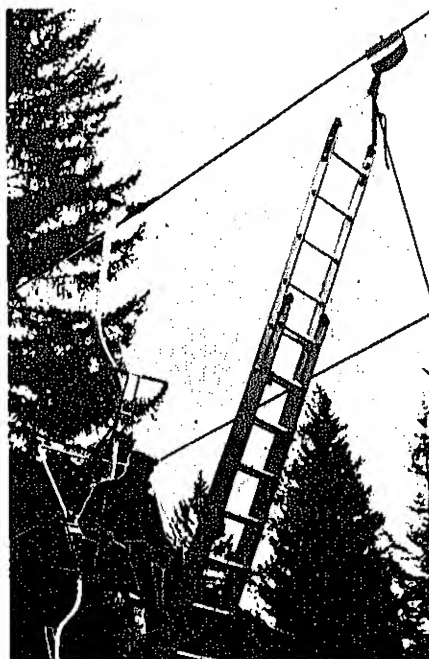


Figure 7. Evacuation of double chair lift using extension ladder.

*Pole Descent Devices*⁴ The pole, made up in sections for various heights, is supported by the main lift ropes. The evacuee (with skis removed) stands on a stirrup and is lowered by ground personnel. This device is difficult to position for appreciable line heights, or when working under adverse wind conditions, or on steep, icy slopes (figs. 8 and 9).

Ascent or Access Equipment

Chair lift evacuation procedures used in the United States are premised upon accomplishing the evacuation without a crew member actually going to the chair to assist the evacuees. The removal of skis and assistance to passengers for ladder evacuation is an exception. This subject is discussed further in connection with gondola evacuations, which require an attendant at the carrier as an essential part of the evacuation plans.

PROCEDURES FOR GENERAL EVACUATION OF GONDOLAS

Evacuation of carriers on a gondola system is similar in many respects to that of a chair lift with these significant variations:

- Exposure of passengers is less severe and evacuation speed may be sacrificed to a degree for added passenger safety.
- Heights in this system may be greater than those encountered with chair lifts.
- Passengers are apt to be small children, the aged, or the handicapped who will be unable to participate unassisted in a conventional chair lift method of evacuation.
- Passengers are not wearing skis. This simplifies an evacuation procedure, since removal of skis is not required, but complicates it in other respects. Passengers lowered to a snow surface must be transported to a shelter area. There is also a problem of returning skis and poles to their owners following an evacuation.
- The enclosed gondola is often equipped with a light line or cord to raise the rescue rope to position. A rescue rope support point may be incorporated in the carrier; this ensures proper positioning and minimum damage to the rescue rope. If the door of the gondola is locked, it may present a problem in setting up the evacuation.

Rope Evacuation

As with chair lifts, rope evacuation of gondolas is the most widely-used method. The advantages and limitations of the method are virtually the same as for chair lifts, with these significant variations:

⁴*Distributor, Poma Aerial Tramways, Woodstock, Vt.*

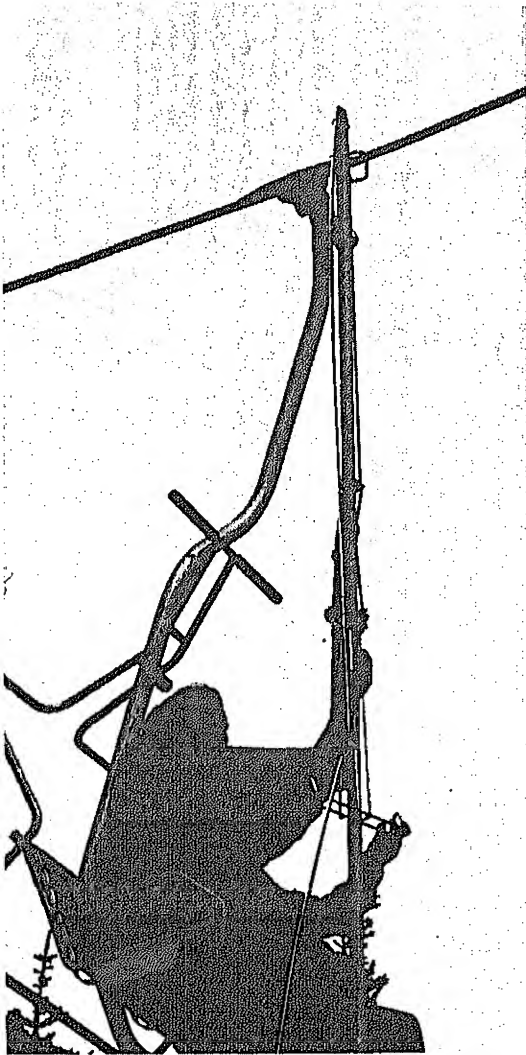


Figure 8. Evacuation of double chair lift using a pole-type mechanical descent device.

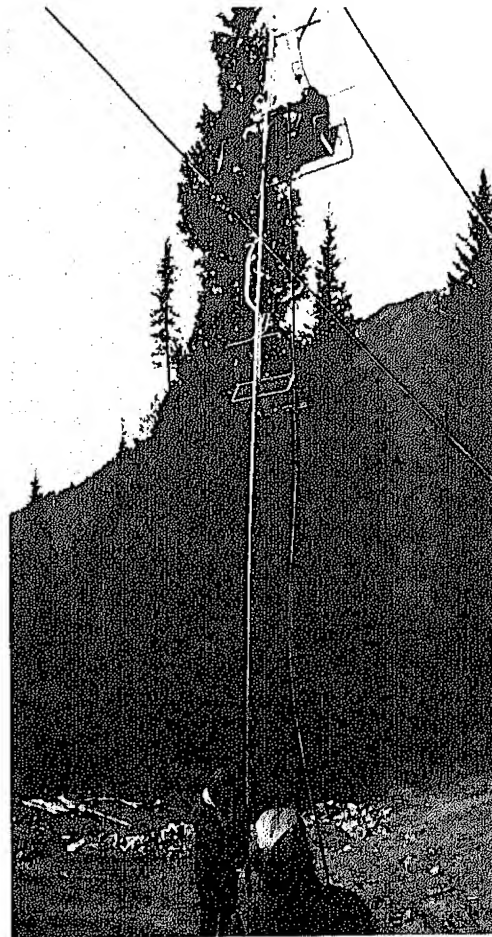


Figure 9. Pole evacuation device convenient for individual evacuation in a terminal area.

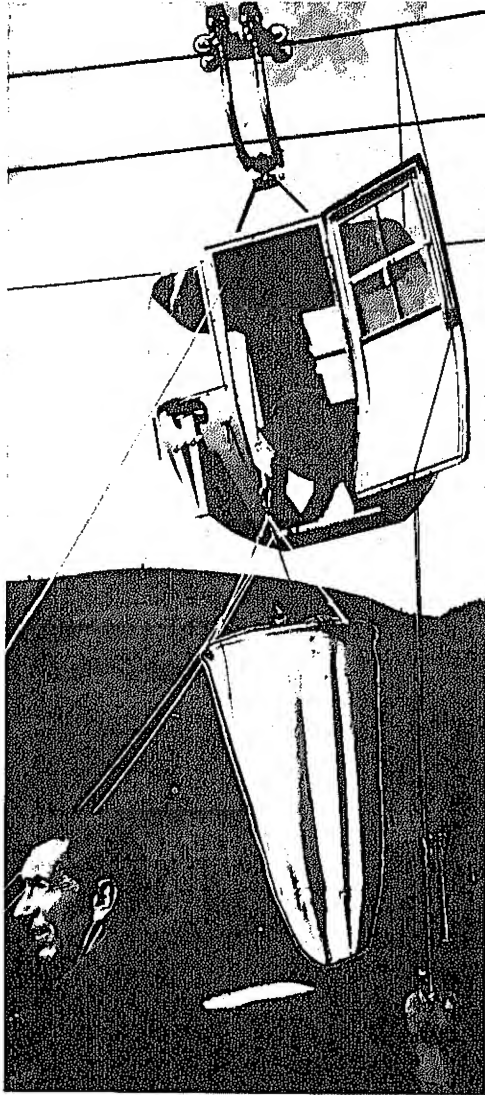


Figure 10. Gondola evacuation using a canvas bag.

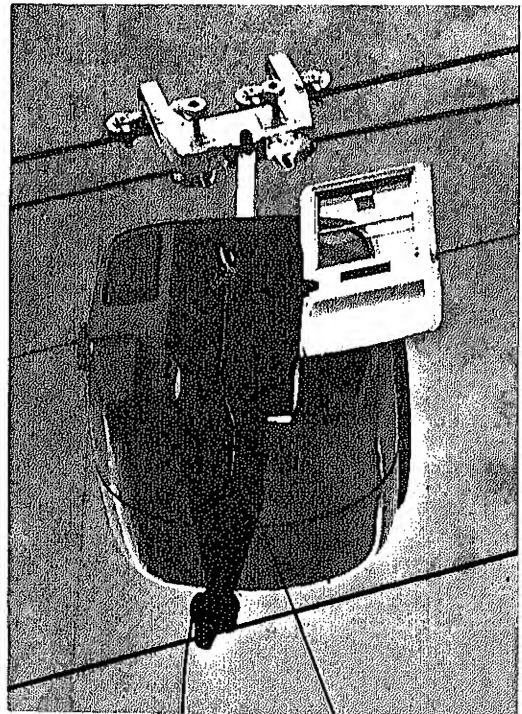


Figure 11. Rope evacuation of six-passenger gondola using descent control device and backup belay.

● **Rescue Rope.** The rescue rope is supported in the carrier rather than over the support cable. It is raised to position by passengers or a crew member lowering a cord to the ground crew, raising the rope to the carrier, threading it through a support, and returning the end to ground level. A crew member will be required to go to the stranded carrier if the passengers cannot accomplish this task; it is probable that this assistance will be needed. Speed and safety factors are improved by such assistance.

● **Rescue Devices for Evacuees.** Gondolas facilitate the use of virtually all passenger suspension devices. The T-shaped seat and standing T-device are used the same as for chair lifts. Containers or bags are widely used (fig. 10). The harness or sling method is frequently used since passengers or a crew member can assist in placing and adjusting the device on each evacuee. The suspension device should permit the evacuee to have both hands free to guide himself over the door sill when leaving the gondola.

● **Descent Control.** Usually, the rate of descent of an evacuee from a gondola is controlled by a rope belay (see Controlling the Descent of the Evacuee, page 13). The presence of a crew member in the carrier permits the use of a mechanical descent control device, although the advantages over a ground belay are insignificant. Once the carrier is cleared, the crew member assisting in a gondola evacuation may move along the main cable to another carrier, be lowered by the ground crew using the rescue rope, or use a self-evacuation descent control device such as *Sky Genie*⁵ (fig. 11).

Ascent or Access Equipment

Most gondola evacuation procedures are premised upon a rescue crew member going to each carrier to expedite the evacuation. This requires that the crew member either climb vertically to the carrier or travel along the support cable from an adjoining tower or structure (fig. 12).

Climbing to the carrier using conventional mountain climbing techniques (Jumar Method or Prusik Method) is slow and requires extensive training and conditioning (fig. 13). Hand-powered mechanical ascent devices such as the *Climbing Seat*⁶ (fig. 14) are less tiring than mountain climbing techniques and are satisfactory except for extreme heights. Both electrically-powered and internal-combustion-engine-powered climbing units are available from European suppliers in either single- or double-seat models. The ascent method selected must be practiced to develop speed and proficiency. The method of placing the climbing rope must be established and, particularly when passengers participate, instructions must be clearly presented.

Traversing the main support cable is the preferred method of reaching stranded carriers (fig. 15). It involves transporting a crew member along the cable in a light-wheeled vehicle, somewhat like an inverted bicycle. The crew member is seated and uses a safety belt or line

⁵Manufacturer, Descent Control, Inc., 657 W. 19th Street, Suite 1, Costa Mesa, Calif. 92637.

⁶Distributor, Poma Aerial Tramways, Woodstock, Vt.

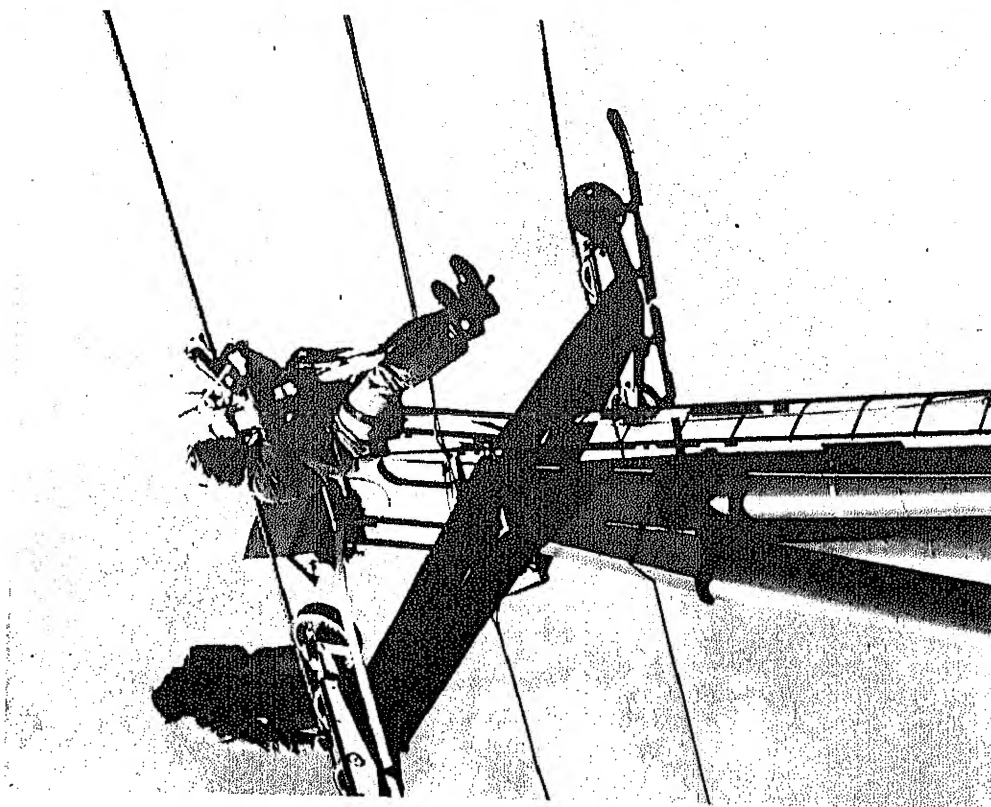


Figure 12. Tower ladder used to locate access device on tramway cable.

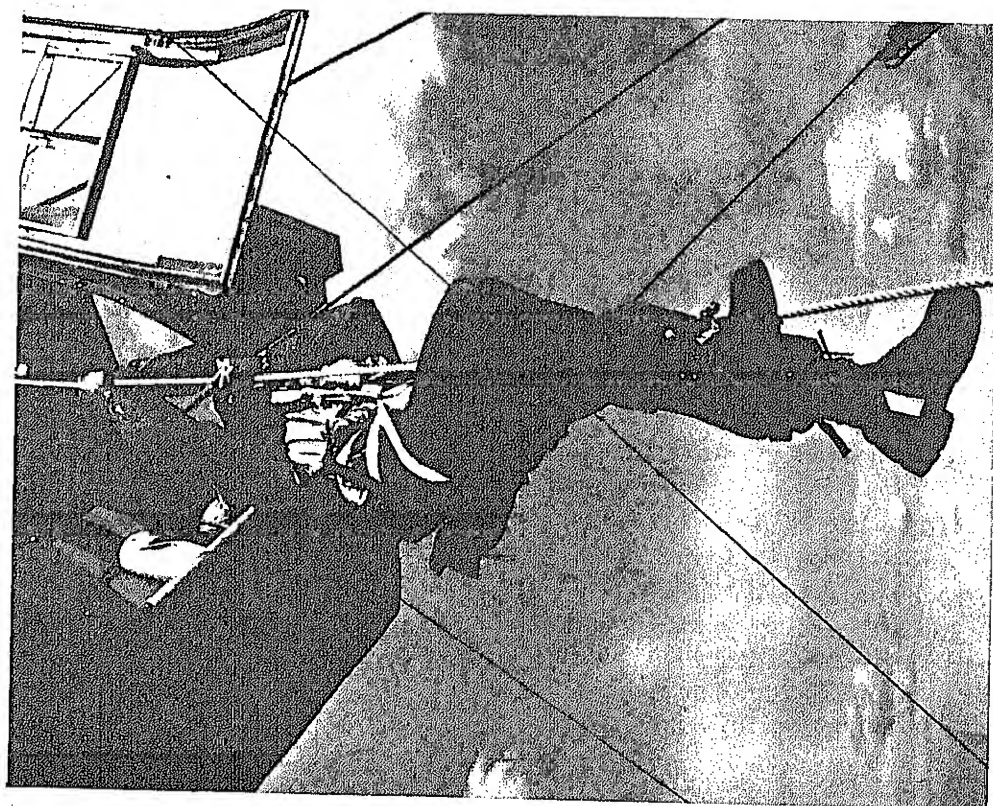


Figure 13. Attendant ascending to stranded carrier using mountain climbing techniques.

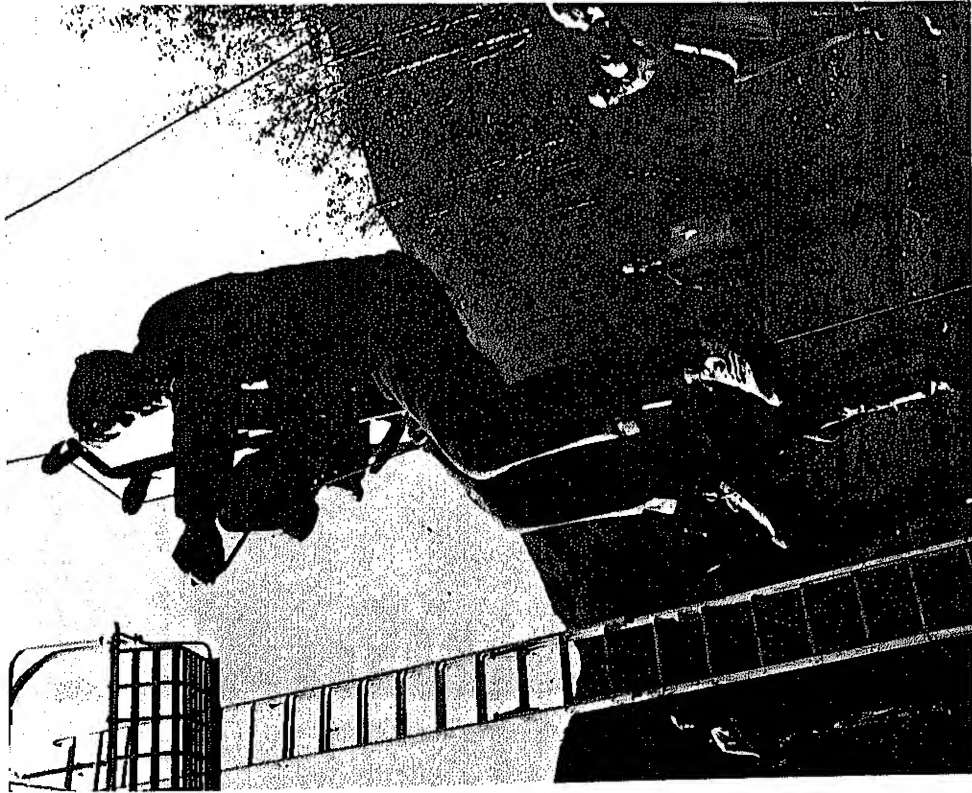


Figure 14. A hand-powered mechanical ascent device for access to stranded carriers.



Figure 15. A mechanical device for access to carriers by travel along cable. Note safety device.

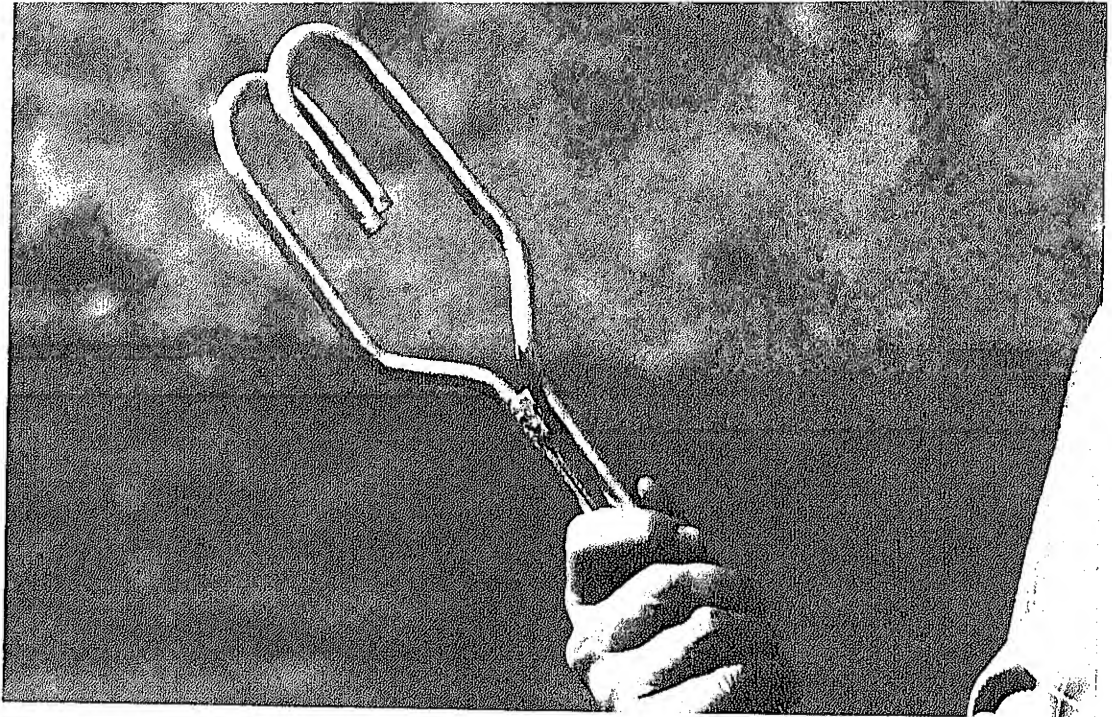


Figure 16. Cable attachment of safety device used by evacuation personnel working above ground.

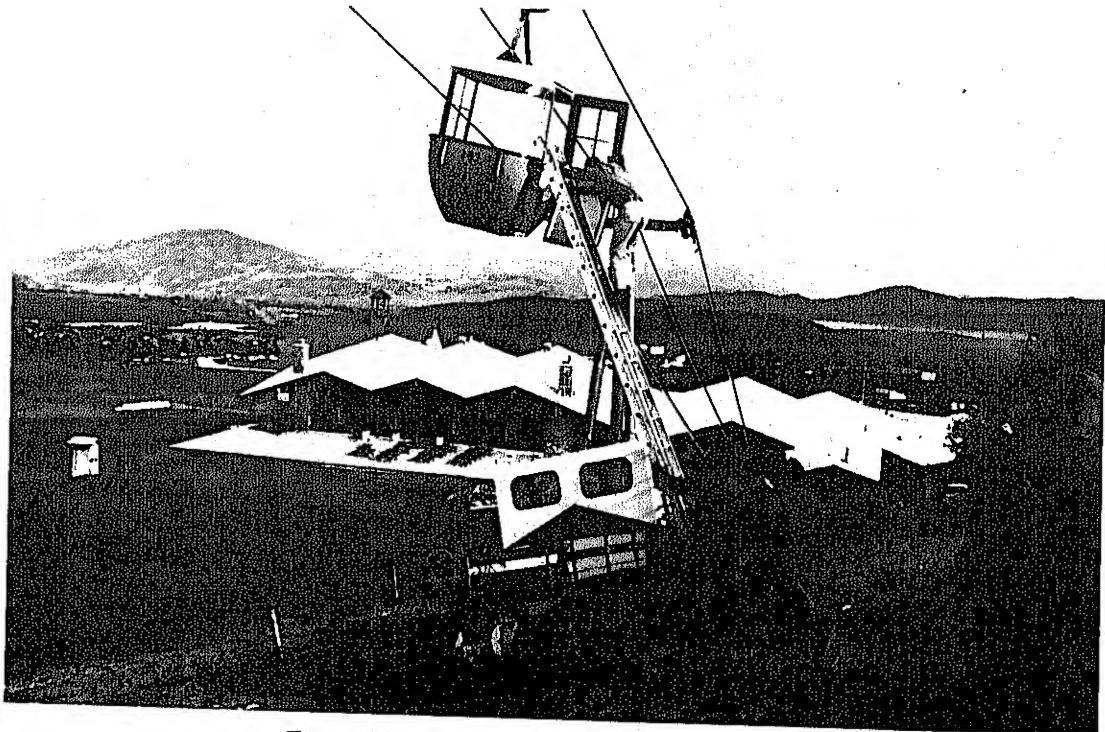


Figure 17. Ladder evacuation of a gondola.

to the main cable. When cable inclination is small, the vehicle may be pulled along by a line to ground crew members. Usually, the vehicle is placed on the line from a tower above the stranded carrier and travels down-line by gravity. Speed of travel can be regulated by a line to ground crews or by brakes. The vehicle must be light, have good brakes, and be easily assembled.

When a crew member arrives at the stranded gondola, he steps from the vehicle onto the gondola roof. How he enters depends on the design of the gondola. Upon completing the evacuation of a unit, the crew member returns to the vehicle, moves it past the gondola grip or carriage, and continues down line. This procedure is dangerous for the crew member involved and must be assigned only to personnel accustomed to working at extreme heights. When the crew member is outside the gondola, every safety precaution must be taken, including use of a safety line attached to the main cable or gondola (fig. 16).

Ladder Evacuation

When line profile and access permit, ladder evacuation of gondolas is most expedient (fig. 17). The method precludes all problems of a crew member's access to the gondola and opening the door. An independently supported ladder system is preferable but expensive. When the gondola is used to support a ladder, provision for positive attachment must be made, since the carrier is free to swing and will rise as passengers are unloaded. Light metal or fiberglass ladders are preferable to those made of wood.

Mechanical Equipment Evacuation

The use of cherrypickers and similar mechanical equipment is practicable for gondola systems when the location, line profile, and access permit. In extreme cases, helicopters have been used (this procedure is discussed on page 27).

Other Methods

The potential exists for a future arrangement where a stranded, fully-loaded gondola could be detached from its hanger, carriage, or other support and lowered to the ground by a mechanical winch. When perfected, the method should speed the evacuation process and enhance the safety of passengers.

EVACUATION OF LARGE-CABIN, REVERSIBLE TRAMWAY SYSTEMS

Evacuation of cabins on reversible tramway systems must be considered on a case-by-case basis. For tramways with heights exceeding 250 feet above the ground and for crossing of inaccessible terrain, rescue systems are mandatory. For example, in Royal Gorge, Colorado, it is impractical to consider lowering the evacuees to the surface below the line. Although it is extremely unlikely that the need for carrier evacuation will arise, plans and preparations must be made. The following are general considerations:

- The decision to evacuate the carriers of a large-cabin reversible tramway must have the concurrence of supervisory operating and management personnel.

- Speed in evacuation is secondary to safety. Emphasis should be placed upon service to the stranded carrier, comfort of the passengers awaiting rescue, safety in the evacuation procedure, and safe transport or care of the evacuee upon reaching the surface below the tramway.

- An attendant is always present in a cabin designed to transport seven or more passengers. He has both normal and emergency communication with the drive terminal, the information and training necessary to fully implement an evacuation when ordered, and is capable of maintaining order and assuring the well-being of passengers awaiting rescue.

- Passengers may include small children, the aged, the handicapped (including those using wheelchairs), the mentally retarded, and others who may require special care and consideration during an evacuation. They are likely to be poorly dressed for exposure to the elements or for extended confinement in an unheated carrier.

Evacuation Procedure

The conventional method of evacuating a large aerial passenger cabin is as follows: When the order to evacuate is issued, the tramway is secured from any further cabin movement. Ground crews and transportation (if possible) are sent to a point below the carriers. Trained evacuation personnel are readied for the ascent to the stranded cabin or dispatched to the cabin via the track cable. Passenger comfort teams prepare to service the cabins; their activities are regulated by the number of passengers, temperature, and length of evacuation time contemplated.

The actual evacuation of the carrier is carried out in the following steps: The descent control device and line recovery winch are removed from storage and placed in previously prepared brackets on the cabin ceiling or floor. A rescue line is threaded from the winch drum through the descent control device and attached to a passenger evacuation device. The floor hatch or door is opened. Passengers are secured in the evacuation device and guided through the opening one at a time. While the evacuee is being lowered, the descent control device is used to limit his speed. When he reaches the surface, ground crews assist him from the evacuation devices. The cabin attendant uses the winch to raise the line and device, and the process is repeated.

The procedure is safe when good equipment and trained personnel are involved, and it is well received by most evacuees; however, it is slow, and the line recovery process may be extremely tiring for a single cabin attendant. The descent control device must have good brakes that do not overheat in continuous use. Structurally, the device must accommodate a passenger weight of 250 pounds with an adequate reserve.

The winch drum must accommodate a wire rope of sufficient length to reach the ground from the maximum cable height at the highest point of the tramway line. The winch should contain a mechanism that places the rope on the drum without fouling, and variable speed is desirable.

A variation of the above procedures provides for lowering a passenger evacuee at the same time the line and carrier are being recovered from the previous evacuee. This method requires two floor hatches 6 to 10 feet apart or the use of doors on opposing sides of the cabin, a descent control device capable of operating in either direction, and a drum of wire rope approximately 100 feet longer than the greatest cabin-to-ground height. One rescue device is permanently attached to the end of the rescue cable; the other must have a positive clamp which can be adjusted along the cable length as cabin-to-ground height changes with the unloading of passengers. Compared to the conventional procedure, this method is faster, equally safe, and less tiring for the attendant, since he does not have to recover empty line.

Service to a Stranded Carrier

Service to stranded carriers to ensure the physical well-being of the passengers is an integral part of evacuation. Frostbite or death from hypothermia, hunger, thirst, or need for medical attention must be prevented. Comfort is secondary to safety, but it is extremely important when an evacuation is extended over a considerable length of time.

The evacuation of a large-cabin aerial passenger tramway is likely to require an extended period of time because of the large number of passengers involved and the adverse conditions of the location. However, evacuation is simplified by concentrating rescue activity at one or two points. In addition, the carrier offers a measure of protection from the elements. Service to stranded carriers should meet the needs of passengers awaiting evacuation, such as blankets and/or warm clothing, cabin heat, portable toilet units, warm food and drink, reassurance of passengers, and communication with passengers' friends if feasible.

Passengers in gondola units would require the same services if for any reason an evacuation extended overnight or for any period in excess of a few hours. Chair lift passengers in open chairs should be given some measure of protection from wind and cold while awaiting evacuation.

Helicopter Evacuation

Successful helicopter evacuation of gondolas and large-cabin carriers demands a combination of factors: extremely well-qualified personnel; proper equipment; and ideal weather and aircraft operating conditions. Since helicopter evacuation is not completely dependable at all times and under all conditions, it cannot be specified as a primary method of carrier evacuation. However, it can be used as a supplementary procedure to support more conventional evacuation methods, particularly in servicing occupants in stranded carriers and for assisting maintenance personnel or evacuation crews working in the area.

A helicopter support plan should provide for the delivery of a capsule to a prearranged receiving bracket at the outside door of a carrier. This bracket enables the helicopter to deliver the capsule, immediately detach from it, and move away. No plan should be considered which envisions the aircraft hovering in position for loading or unloading of cargo or passengers. Electric powerlines, communication and control lines, and rescue cable systems are obstacles, and wind, fog, and darkness are natural deterrents to successful helicopter operations.

APPENDIX A

The following is a joint statement by the National Ski Areas Association and the National Ski Patrol System, "Chair Lift Evacuation Considerations and Recommendations,"¹ excerpted from the National Ski Patrol System's "Lift Evacuation Technical Manual." The statement defines terminology, procedures, responsibilities, and equipment that are relevant to the evacuation of chair lifts.

- 1.1.0 *Minimum Requirements.*² Each area should meet the following minimum requirements related to the evacuation of chair lifts:

1. A detailed written plan of evacuation.
2. Equipment necessary for evacuation.
3. Adequate training of personnel.

In addition, each area should adhere to the regulations established by the authority having jurisdiction.

- 1.2.0 *Types of Evacuation.* Two general types of evacuation from chair lifts are recognized. (Removal of passengers from the lift by use of the auxiliary engine using regular unloading stations is not considered evacuation.)

- 1.2.1 *Individual Evacuation.* The removal of an occupant(s) from a single carrier in a safe manner. This type of evacuation is limited to areas adjacent to loading and unloading areas and is generally required when a passenger(s) fails to load or unload successfully.

- 1.2.2 *General Evacuation.* The removal of all occupants of a chair lift due to the inability or inadvisability of moving the lift in the normal manner.

- 1.3.0 *General Considerations Relating to Individual Evacuation.* Time is of the essence for this type of evacuation. Normally the evacuation is required due to the failure of an individual to properly load or unload from a chair. The area adjacent to the loading and unloading stations is the limit for consideration of individual evacuation. The detailed plan should include methods and equipment necessary to enable the attendant or lift operator to assist in the rescue of the passenger.

- 1.3.1 *Individual Evacuation.* Authority to initiate evacuation must be given to the lift operator and the loading and unloading attendants. Time does not permit any delay in such a decision. The individual making the decision

¹ Revised 8-20-73.

² See American National Standards Institute, B-77.1, 1973, Sec. 3.2.4.3.6.

must first actuate a stopping device that will assure immobility of the lift until reset, and proceed immediately with the evacuation.

- 1.4.0 *General Evacuation.* Overall considerations and planning are more broad for general evacuation than for individual evacuation. The time factor for evacuation is often a function of existing weather conditions. General evacuation starts with a decision by Area Management to initiate evacuation, and it is not complete until all lift occupants are not only removed from the lift, but are returned to base facilities. Sufficient devices and trained personnel should be available to enable the lift to be evacuated within a reasonable time.
- 1.4.1 *Initiation of General Evacuation.* Authority to proceed with total evacuation and the responsibility of the evacuation should be assigned to specific management personnel with appropriate backup provisions. The cause of lift immobility and the probable time to restore the lift to operating condition weighed with the probable exposure conditions to which the lift occupants are being subjected should be evaluated before the decision to initiate general evacuation.
- 1.4.1.1 *Evacuation Alert.* When the possibility of a general evacuation exists, area personnel to be involved should be placed on alert. An initial decision for an evacuation alert should be made with a minimum of delay. Under the alert, lift personnel will ascertain the possibility of using auxiliary power to unload passengers, making the necessary power train connections and initial warm-up of the auxiliary engine. A detailed examination of the lift line by lift and patrol personnel shall be started if required. Passengers should be reassured and advised of possible evacuation. Evacuation crews and equipment shall be placed in readiness.
- 1.4.1.2 *Evacuation.* Upon a determination by the authorized person that the evacuation shall be undertaken, the lift power shall be disconnected and the evacuation plan initiated.
- 1.4.1.3 *Evacuation Plan.* Area Management shall prepare a plan(s) for evacuation from chair lifts. This plan should provide for the instructions, training, and equipment necessary. The evacuation plan should include, but not be limited to, the following:
 - 1. The designation of one individual who has complete authority and responsibility regarding the restarting of the lift.
 - 2. The maintenance of communication between lift terminals, evacuation personnel, and supervisory personnel.

3. Provisions for keeping passengers informed of the progress of the evacuation.
4. Method and equipment to be used for evacuation.
5. Provision for first-aid facilities and comfort of evacuees.
6. Provision for transporting evacuees and their equipment to the base area.
7. Return of equipment to proper location in ready condition.
8. Adequate provision for dissemination of information to the press and other interested parties by management.
9. Post-evacuation evaluation of personnel involved.

1.5.0 *Evacuation Models.* No single evacuation method has been found to be suitable for all ski areas and chair lifts. The most satisfactory method, or methods, for a specific chair lift will depend on the lift arrangement, terrain, general type of passenger using the lift, anticipated weather conditions and, when applicable, summer or night operation. Area Management should select the method, or methods, that best suit conditions anticipated.

1.5.1 *Ladder Evacuation.* Use of a ladder with a fitting to adequately restrain the top of the ladder (generally on the haul rope) is adaptable where the height of the lift, the snow depth, and the terrain gradient are small. This method is particularly adaptable to individual evacuation. It provides a method of getting a member of the evacuation team to the chair to offer direct assistance to an occupant.

1.5.2 *Rope Evacuation.* Lowering lift passengers from the chair by use of a nylon or polyester rope³ over the haul rope or around a pulley or similar device attached to the haul rope or chair. This method is adaptable to a wide variety of terrain conditions. Occupants can be lowered directly to the snow surface without the need for removal of ski equipment. Choice of equipment and belaying of the lowering rope are most important.

³*Natural fiber ropes or other synthetic ropes (Polyester rope is known by several trade names)*

- 1.5.3 *Self-Evacuation.* Any form of evacuation from a chair lift that requires the occupant to perform any duties other than securing himself to a device as instructed, or climbing down a ladder. Self-evacuation shall be limited to trained area personnel authorized to do so under specific conditions set forth by management.
- 1.5.4 *Other Evacuation Methods.* Other methods of evacuation have been successfully used. Specific methods shall be evaluated for the configuration and conditions anticipated.
- 1.6.0 *Evacuation Equipment.* The equipment designated for use in evacuation shall be appropriately located, suitably protected, and adequately maintained so that an evacuation can proceed with a minimum loss of time. Its use shall be limited to training and evacuation purposes. Equipment shall be inspected at least annually and always after its use.
- 1.6.1 *Ladders.* Metal or fiberglass ladders are generally preferred to wood ladders. An attachment should be provided to the top of the ladder to permit ready attachment to the haul rope or chair. Ladders shall be structurally adequate for the use intended.
- 1.6.2 *Lowering Ropes.*
 - 1.6.2.1 *Size and Material.* The rope shall be of nylon or polyester material³ not less than 7/16-inch in diameter. Where the rope is passed directly over a wire rope, three strand rope with a hard (short) lay is preferred. Where rope is passed over a pulley or other mechanical device (i.e., Line Saver), braided or soft lay is equally acceptable.
 - 1.6.2.2 *Connections and Fittings* (lowering rope to evacuation carrier). The attachment of the lowering rope to the evacuation carrier shall be of a type that will not result in excessive stresses being placed on the connection. Sharp bends in the lowering rope are not permissible. Suitable knots are permissible.
- 1.6.3 *Belay Evacuation Carriers.*
 - 1.6.3.1 *Types.*
 - 1.6.3.1.1 *Stand-Up Type.* This device permits the occupant to place his skis on a platform and attach a security tie. Exit from the chair is made by

³ *Natural fiber ropes or other synthetic fiber ropes (i.e., polypropylene) are not acceptable. Polyester rope is known by several trade names (e.g., Dacron).*

the occupant standing up when the lowering rope is tensioned by the evacuation team. The stirrup must have side bars to preclude skis from sliding out sideways.

1.6.3.1.2 *Seat Type.* This device requires that the occupant place a seat or bar in position on top of the chair seat, attach a security tie and slide from the chair seat when the lowering rope is tensioned. The bottom of the device must be smooth to permit it to slide freely off the chair.

1.6.3.1.3 *Sling Type.* This device is placed around the occupant's body in the manner of a vest with a security strap being fastened across the chest by the occupant. When the lowering rope is tensioned by the evacuation team, the occupant slides out of the chair.

- 1.6.3.2 *Security Tie.* The evacuation carrier shall have a security tie that will prevent an occupant from falling from the carrier when properly attached. The device shall be designed so that the occupant can adjust and secure the device. Consideration shall be given to the ability of the occupant to secure the device under adverse conditions and permit a visual check of the proper installation by a member of the evacuation crew.

APPENDIX B

The National Ski Patrol System's "Lift Evacuation Technical Manual" (1974), describes procedures and equipment used in the evacuation of chair lifts. Copies of the manual are available from:

National Ski Patrol System
2901 Sheridan Boulevard
Denver, Colorado 80214

APPENDIX C

RESPONSIBILITY OF THE FOREST SERVICE REGARDING THE EVACUATION OF AERIAL PASSENGER TRAMWAYS

As an authority having jurisdiction over land use involving the public operation of aerial passenger tramway facilities, the USDA Forest Service has several responsibilities regarding the emergency evacuation of these facilities which must be met. These responsibilities can be categorized as follows:

- Initial planning.
- Operational adequacy and readiness.
- Procedure and equipment development.

Initial Planning

Regardless of the precautionary measures taken to prevent the interruption of both normal and emergency operations and the provisions for passenger rescue, the possibility of the eventual need for carrier evacuation on any aerial passenger tramway must be recognized and provided for. Basic to such planning are the following:

- Selection of a type of lift appropriate for the terrain traversed and the climatic conditions encountered.
- Cabin and carrier design incorporating features that would facilitate passenger evacuation.
- Preparation of detailed evacuation plans resulting from the joint efforts of management responsible for public safety, organizations or personnel responsible for performing the evacuation, and authorities exercising jurisdiction in the area. The plan must consider every possible condition of passenger use, the most adverse operating conditions, and the most disadvantageous combination of factors that could affect evacuation. It must incorporate a program that starts with the initial alert and carries through to such followup procedures as the preparation of reports. Essential elements of the aerial tramway evacuation plans must be made part of contractual arrangements with the recreational area. FSM 2342.53, Winter-Sports-Site Safety Plan, requires that the plan be updated annually, and this provision should include a review of aerial passenger tramway evacuation requirements.¹

¹Regional supplementation must be complied with; for example, R-2 Supplement No. 60, September 1972, 2342.33, Evacuation.

Operational Adequacy and Readiness

The authority having jurisdiction is responsible for concurring in the operational adequacy of an evacuation plan prepared by area management. This authority may share in preparing the plan, along with the ski patrol, insurance interests, and others cooperating with management. Periodic inspections by the authority assure that management maintains the program in a state of perpetual readiness during public operation of aerial tramway facilities.

Operational adequacy must include:

- Evacuation systems capable of removing passengers from carriers at any point on the lift under any possible operating condition, including inclement weather and darkness.
- A system or combination of systems that can remove the passengers from fully loaded carriers under the most adverse operating conditions within a time limit appropriate for the type of carrier and the climatic conditions encountered.
- Personnel training and availability to perform all phases of the evacuation within the time limit specified.
- Designation and availability of evacuation gear and mechanical equipment necessary to carry out aerial lift evacuation. This includes the number, location, and content of evacuation caches in terminal areas and along lift lines; the designation of mechanical equipment that is to be available for evacuations; and provisions for nighttime evacuations. It also includes information on emergency units or equipment which can be called upon in an emergency.
- Establishing reporting requirements and procedures for any interruption of aerial tramway operation which involves the evacuation of carriers, and the reporting of injuries or deaths, if any, resulting from the evacuation.

Procedure and Equipment Development

The authority having jurisdiction should participate in the preparation of rules and regulations for aerial passenger tramway evacuations. This authority should be knowledgeable about practices, procedures, and equipment available within the industry. Requirements that are being enforced by other authorities locally, nationally, and internationally, should be explored. Authorities should encourage and participate in research and development efforts to improve the speed and safety of evacuation techniques, practices, and equipment.

APPENDIX D

THE AMERICAN NATIONAL STANDARDS INSTITUTE SAFETY REQUIREMENTS FOR THE EVACUATION OF AERIAL PASSENGER TRAMWAYS (ANSI B77.1, 1973)

General Requirements

3.2.4.3.6 Evacuation of Reversible Aerial Tramways and Aerial Lifts. Provisions shall be made for the emergency evacuation of reversible aerial tramways and aerial lifts (see 2.1.13). These shall include a detailed plan of evacuation, equipment necessary for evacuation, and adequate training of personnel. Evacuation drills shall be conducted at established intervals not to exceed one each 12 calendar months, and such drills recorded in the operational log of each tramway or lift (see 3.5.1).

2.1.13 Evacuation — Reversible Aerial Tramways and Aerial Lifts. These installations shall be provided with approved means to evacuate passengers from stranded carriers. For heights over 250 feet, or for locations over obstacles such as rivers, etc., evacuation equipment shall include an emergency carrier system or other approved equivalent rescue device.

Operating Requirements

2.2.1.2 Auxiliary Power Unit — Aerial Lifts. A single auxiliary power unit shall not be used except to unload passengers and for maintenance purposes unless the following requirements are met:

- (4) Evacuation gear and personnel are immediately available in sufficient number and quantity that the entire lift can be evacuated in a two-hour period. Demonstration of the capability will be required before authorization is granted to use the auxiliary power unit for passenger operations.

2.1.9.7.4 Emergency Lighting. Emergency lighting shall be provided in the event of electric power failure to permit:

- (2) Emergency evacuation of carriers.

3.2.1.4 Conductors. He shall be thoroughly drilled in the use of emergency evacuation equipment and procedures.

3.2.1.2 Operators. An operator shall be in charge of each tramway, lift, or tow. He shall be trained and experienced in normal operational and emergency procedures.

Test Requirements

2.1.14.1 Reversible Aerial Tramways and Aerial Lifts — Additional Requirements. Inspection shall also cover:

- (3) Evacuation equipment and procedures, including an actual test at the most difficult location.

